Chapter

How the Data Provided by IIoT Are Utilized in Enterprise Resource Planning: A Multiple-Case Study of Three Change Projects

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Abstract

An extreme increase in data production has taken place over the past few decades with a large number of sensor and smart devices acquired from distributed data sources. Industrial Internet of Things (IIoT) enables seamless processing of information by integrating physical and digital world devices that can be used ubiquitously. This multiple-case study analyzes how the data generated by the IIoT benefit enterprise resource planning. In the analyzed cases, IIoT has been produced using and integrating various digital services and software in the enterprise. Data produced by IIoT might be raw data or pre-analyzed by the IIoT service provider according to the enterprise's needs. Services based on IIoT solutions ensure competitiveness within the enterprise since IIoT is flexible and easy to apply on future demands. IIoT generates increased amount of data and enterprises can utilize it to provide significant benefits to their operations. The cross-case conclusions emphasize that improving operational processes with data does not provide maximal benefit to the enterprise. Data-driven procedure and the entire change project (digital transformation) together with new procedures will provide most benefits to the enterprise.

Keywords: multiple-case study, digital transformations, change project, industrial internet of things, enterprise resource planning

1. Introduction

An emergent number of enterprises are deploying new solutions utilizing Industrial Internet of Things (IIoT). IIoT solutions provide many benefits to an enterprise, but they also drive the enterprise to redesign its operations to data-driven processes. On the other hand, the solution adjusts the enterprise's services to make them more profitable and precise. This requires the enterprise to make strategic but also organizational changes in order to succeed in the change [1]. During the development process, enterprises brainstorm, generate ideas, compare and test IIoT solutions for later changing the business model. The services provided by IIoT require not only an IT competence developer but also competence in

business activity insight and expertise. IIoT solutions also affect sales, marketing, and mostly development of service concepts. In some cases, IIoT can be the base of a new service concept or a total digital transformation process.

Change, derived from IIoT solution, requires time in every organization. Change includes planning, deployment, and implementation of current solution. In some cases, the Industrial Internet can affect the enterprise's whole strategy by remodeling or modifying its operations. IIoT solution may even influence value proposition since data drive the operations and accurate data provide new possibilities in daily business. Due to technical solution that collects data, new information is created. Therefore data can even have an impact on enterprise management tools; using of data driven management tools to assess processes [1].

This chapter presents a multiple-case study research (MCSR) of three change projects in which new IIoT solutions have been put into operations in three different Finnish enterprises. The research questions are:

- How and when the enterprise recognizes the changes required by applying the new IIoT solution?
- How the enterprise applies the new data provided by the IIoT solution?
- Why the change is crucial, and how the whole organization succeeded in implementing the change?

The chapter follows a linear-analytic structure of the sequence of subtopics involving the issue being studied, the methods used, a review of the relevant literature, the findings from the collected and analyzed data, and conclusions and implications from the findings. After the introduction, Section 2 proposes a used methodology of the deliverable. Section 3 handles the theory and how it has been built. Section 4 presents the individual case study analysis. Section 5 includes cross-case study conclusions and concludes the chapter.

2. Research approach

Figure 1 shows how the MCSR approach is applied in this research. The initial step in designing a MCSR consists of theory development (see Section 3), and the next steps are case selection and definition of specific measures in the design and data collection process. Each individual case study consists of a whole study, and

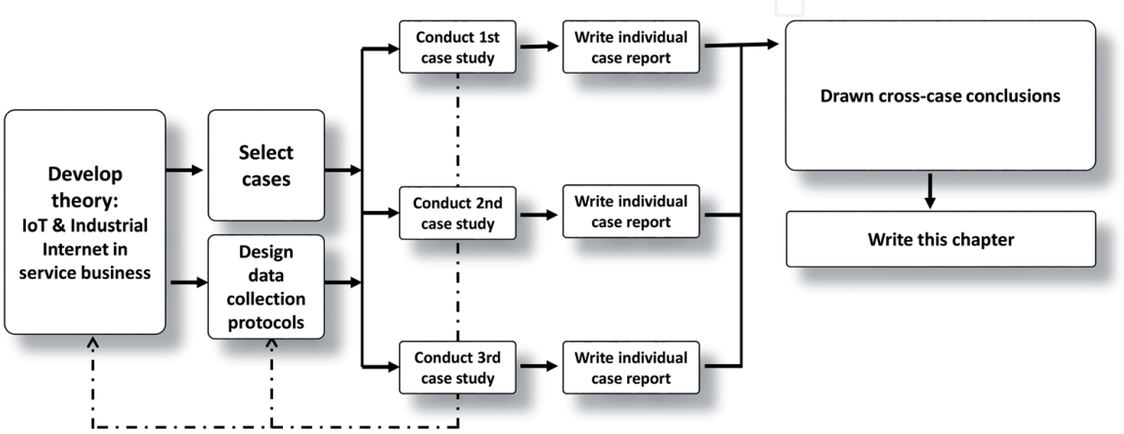

Figure 1.
Applied multiple-case study approach.

then conclusions of each case are considered to be the replication by other individual cases. Both the individual case and the multiple result should be the focus of a summary report. For each individual case, the report should indicate how and why a particular result is demonstrated. Across cases, the report should present the extent of replication logic, including certain and contrasting results [2].

Any use of multiple-case design should follow a replication, not a sampling logic, and choosing of each case should be made carefully [2]. In **Figure 1**, the dashed-line feedback represents a discovery situation, where one of the cases does not suit the original multiple-case study design. Such a discovery implies a need to reconsider the original theoretical propositions. At this point, redesign should take place before proceeding further, and in this view, the replication approach represents a way of generalizing that uses a type of test called falsification or refutation, which is the possibility that a theory or hypothesis may be proven wrong or falsified [3]. This MCSR consists of three individual case studies presented in Section 4. The sources of evidence used in the individual case studies consist of documentation, archival records, interviews of enterprises' top management and IIoT solutions suppliers, direct observations, participant-observation, and physical artifacts. The data are retrieved in a specific time period (cross-sectional), the largest part of the data is qualitative (empirical) and involves purposive sampling and a specific selection of a phenomenon (case studies). Every individual case study was reported separately to the top management of the enterprise in question. Cross-case conclusions were carried out via a document analysis exercise.

3. Industrial Internet of Things in service business

The Internet of Things (IoT) refers to a system of smart devices connected to each other through the Internet [4]. These things include technology that enables them to communicate, sense and interaction with internal space as well as external environment. In other words, physical things can collect data, be connected to other things, and share data. These things can be sensors, smartphones, smartwatches, computers, and home and industrial appliances—anything that can collect, handle, and send data for forward treatment and analyses. First, IoT systems were consumer-centric, but the disruptive nature of this technology has enabled the adoption of IoT technology in a gamut of industrial settings, thus leading to the development of Industrial Internet of Things (IIoT) technology [5]. Technology enables new success stories in every business industry. The true success factors, in order to succeed in IIoT solution implementations, are people in enterprises, processes, and context.

Data alone that are provided by IIoT solutions are not of any value. The collected data connected to business unit's context or other sources of data provide the valuable benefits. Data can be used to understand challenges better or to enhance processes. Collected data may even support management in decision-making process.

By purchasing IIoT solutions, enterprises maintain their competitive advantage. The solution would respond quickly for future spontaneous and accurate demands since things are connected to network and therefore can be updated online. Services can be adjusted both due to competition, commercial, and also to legislation requirements. IIoT solutions mostly include technology, network, and software. In addition, they are always designed for enterprises' needs and desires. IIoT solutions are custom-made and they are to be integrated into the enterprise's existing systems. Data can be provided as raw data, pre-analyzed, or expressed in visual dashboards.

Since the experimental period of IIoT solutions has been exceeded in the past few years, companies are today seeking sustainable solutions to support their operational processes and bringing real value to the company. The technology behind the solution has been proved to operate as it should which means that the expected data can be provided by it and it is accurate. The price of sensors and detectors has been decreasing, which means that enterprises' investment of the technology solutions covers only project and implementation costs. In addition, data storage and several cloud services are available at reasonable price. Low maintenance costs encourage companies to store data for further need.

There are several data strategies that companies can apply data provided by IIoT solutions. Companies can collect data in order to use it to support and enhance their own operational process and business activity. Data can be used not only to guide operations but also show real-time data. These are valuable in enterprises' daily operations. Data can be used to prevent unnecessary actions, the so-called fire situations. In optimal conditions, the data are used to forecast and control actions before they turn into these fire tasks.

For creating business model around Industrial Internet fundamental, there are five key elements:

1. Value creation in service network

2. Building and developing global service network

3. Customer-centric and cost-efficient service process planning

4. Creating positive customer experience

5. Inventing profitable revenue generation logic

When designing a new business model that is based on IIoT, enterprises can use these elements to base it on. This encourages enterprises to place customers and services in the center in order to not only gain higher customer satisfaction but also increase sales in service. These elements can also be applied to develop business activities and generate profitable core or supporting functions.

Because the amount of data grows at an unprecedented scale and depth with the proliferation of smart and sensor devices, big data analytics has emerged as a key initiative in the IIoT field [6–8]. Recently, artificial intelligence (AI) has become a key factor in big data analytics in industrial applications [9].

4. Empirical cases

This section briefly describes the three empirical cases that belong to this multiple-case study analysis. The individual case reports were published earlier, but this section summarizes their main research results with regard to this MCSR.

4.1 Case I: OnniBus.com

OnniBus.com (later OnniBus) started their transportation business at 2012. Within few years, they have managed to grow their business to one of the largest brands in Finland. OnniBus has disrupted mass transportation with competitive, rather low, pricing. Today, they move customers frequently in the most popular routes and also daily all around Finland with their 128 buses. About 28 million

kilometers are bring customers from one city to another. With Telia Connected Vehicle solution, OnniBus primarily seeks savings in costs.

OnniBus among others is the first transportation company that applied the Telia Connected Vehicle solution. This solution monitors ground vehicles in action and it optimizes the operation of hardware by using real-time data installed in the vehicles. In addition, the solution enables combining different services that beforehand were provided to OnniBus from different service providers. When considering the bus driver, it also takes much less effort to follow only one screen rather than several.

In the early phase, Telia's solution was installed in all 68 double-decker buses and later in the 60 single-storey buses. The service requires that the driver of the bus logs into the vehicle system with an identifying digital card, which is a very secure way to log in. In the past, drivers did not always remember to sign in and no data could be obtained at that time. OnniBus uses Telia's solution to remotely read digital plotters and cards. They are able to monitor remotely that driving times are being realized and digital cards are always being used by drivers. This kind of data is a very powerful management tool. The CEO of OnniBus Lauri Helke sums up "what you don't measure, you can't lead." In order to motivate drivers to drive more ecologically, OnniBus started to publish driver-specific results to the staff every month. Such transparent information encourages everyone in the company to see what kind of data can be achieved with financial driving.

In order for OnniBus to achieve savings in costs, the most important thing about implementing this service is to report about OnniBus driver habits and fuel consumption per driver. Only the fuel savings from the data generated by Connected Vehicle-solution will be 1–5% annually. In double-decker buses alone, OnniBus consumes approximately 5.5 million liters of fuel per year, which means a fuel cost of EUR 6 million. This saving as such is significant. Since Telia's solution also monitors the vehicles, there are savings directly on tire costs and other vehicle operating costs. In addition, it provides an ecofriendly approach to bus transportation business.

4.2 Case II: Pohjolan liikenne

Transportation industries are under critical inspection since the environmental cause. In order to utilize different sources of data and manage with data, companies can achieve massive advancements by how they optimize their actions. Focusing on fuel economy and improving effective fuel consumption are significant ecologically friendly approaches in the transportation industry and furthermore companies reserve in costs.

Oy Pohjolan Liikenne Ab (later Pohjolan Liikenne) has been serving in the transportation industry since 1949. They offer transportation services in commuter traffic, country traffic, local transportation, metropolitan area, order and contract driving as well as Finnair CityBus traffic driving.

Telia's solution means that bus vehicle's actions are being monitored and optimized according to real-time data. Cost-efficient driving and measurement have been challenging before but since the new solution provides data real time, information can be used proactively. Despite that, the savings in fuel are concrete. With that said, data from consumption of fuel are precise and therefore the company has been able to seek the best-practice driving mode for drivers. With Telia's solution, Pohjolan Liikenne can react to drivers' driving habits in real time. Along with the service, Pohjolan Liikenne is able to measure driver's driving index and thereby develop better driving performances. In addition, the company can get an insight into drivers' driving period, breaks, and working hours. In addition, the solution saves data from certain periods and uses data to analyze it according to critical aspects that are relevant for the company. Data can be analyzed for instance with weather.

The other remarkable feature is that Telia's solution monitors the coach vehicles' condition real time. The solution is integrated to the CAN bus which all the coaches include and from there data is collected real time and the output in a readable way. No extra sensors are needed to be installed. The information that already exists can be now used to resolve problems. By adding weather information or how people move, solution can bring data bases together and analyze big data.

4.3 Case III: Delete

Delete Finland Oy (later Delete) is one of the leading providers of full-service environmental services in the Nordic countries. The company was established in 2010. Delete provides business-critical services that require specialized expertise and specialized equipment in three business areas: cleaning services, demolition services, and recycling services.

Delete's priority is to optimize maintenance processes and furthermore to improve their customers' business. Unpredictable demand of maintenance or drainage are usually unpleasant and rarely expensive for customers. Customers' daily actions are being paused during the time needed to manage these kinds of sudden drainages. Delete tested Narrow Band IoT (NB-IoT) solution as a pilot in order to obtain how NB-IoT will help to anticipate maintenance. Delete wants to experiment with technology on how to avoid unexpected service disruption in restaurants and car wash lines and enable proactive maintenance and planning. Today, Delete drains hundreds of wells monthly and most of them at short notice. With the experiment, they aim to create new stable processes that decrease unnecessary visits, develop processes according to better planning, save in costs, and, due to all these, enhance customers' daily business. "The wastewater from restaurants and service stations carries sediment that accumulates in sewer wells built for this purpose. The sensors installed in the wells allow us to monitor the amount of grease and sand accumulated in the wells in real time, while also anticipating the need for emptying the," says Markku Salminen, Director of Development and HSEQ.

Telia generates the pilot with a NB-IoT communications network, cloud data solution and a service interface. For the first time in Finland, NB-IoT remotely read sensors that are used to determine the drainage needs of a restaurant's grease separator wells and a service station's car wash line. NB-IoT technology can be used to track up to thousands of IoT devices. In the pilot, NB-IoT sensors are being installed to anticipate the maintenance and drainage needs of the sand separator wells at Stockmann's restaurant in Helsinki and the Neste K Hatanpää and Neste K Kekkosentie car wash line in Tampere. Pilot's NB-IoT takes advantage of existing 4G networks, but is also compatible with future 5G networks.

Narrowband IoT (NB-IoT) is a global standardized network technology that leverages existing 4G and 5G networks. With NB-IoT, one can connect many devices to network cheaply and reliably. The data sent by the devices can be used to monitor real-time operational and production processes. The battery of the NB-IoT sensor that collects and transmits data can last up to 10 years. It is activated and transmits data only when the programmed measurement limit is exceeded. Hundreds of thousands of devices can be connected to a single access point.

5. Cross-case conclusions

When an enterprise acquires an IIoT solution as a part of the business operations, a change in the organization is always required. The change has a direct impact on the operational process, resource planning, and people that are operating

within the solution in the context. The change also affects employees who are working to provide the service. Every IIoT project with its implementation and accustoming phase in the organization requires time in which the enterprise should be prepared. In order to succeed, the change always requires identifying the change objects early enough and defining the relevant process points. However, the essential prerequisite for the success is the commitment of the uppermost management.

In one analyzed case, the enterprise outlines its new operating process by completely redesigning it based on digitalization and data. In another case, the enterprise adapts new operating processes to apply its own operating environment. Using data to streamline business processes does not bring all the potential benefits to the enterprise. The case study result reveals that when the project as a whole is successful, it will provide the company with benefits in terms of productivity, efficiency, and competitiveness. The change project itself includes, among other things, a clear definition of the cause and goals of the change, communication, staff engagement, and evaluation.

The data provided by IIoT are a valuable asset compared to the competitors of the case enterprises. By analyzing data properly and applying it to the enterprise's own business environment and processes, one is possible to gain business benefits in financial as well as international market aspects.

The study cases showed that enterprises that have strong support and contribution from management team are able to implement IIoT solution within the enterprise. The management team or the CEO of the company drives change projects other than this and they are open-minded of new technical possibilities in their industry. They believe that if they do not take advantage of technical innovation solutions, someone else in the same industry will.

In addition, the individual case studies showed that motivation for each organization level is essential in order to succeed in the implementation of the change project. The new IIoT solution needs to serve motivation for each department: CEO, financial, resource planning, logistics, service and driver's perspective.

In the future, AI will be a fundamental part of business in most sectors. The data-driven digital transformation creates new and modifies existing business processes, culture, and customer experiences to meet changing business and market requirements. Today, the lack of good-quality data in enterprises is the biggest barrier for fully exploiting AI. With good planning, new IIoT solutions can bring good-quality data, but they should be integrated into existing systems not always containing good-quality data. When the amount of good-quality data grows, possibilities to exploit AI improve. However, the success factor of data-driven digital transformation depends on the business strategy and the commitment of the top management, who should put the business strategy into practice.

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